Ground Radiation Antenna using Magnetic Coupling Structure.

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***Abstract* - In this paper, radiation performance of a ground radiation antenna using magnetic coupling structure is compared with a conventional planar inverted-F antenna (PIFA) in terms of the impedance bandwidth and radiation efficiency. The size of the proposed ground radiation antenna is 5 x 10 mm^2, reduced up to approximately 50% while the impedance bandwidth is obtained as 560 MHz (2174~2734MHz), improved by approximately 300% compared to the PIFA. The size of the ground plane is 50 x 20 mm^2, intended for USB dongle and headset applications.**

I. INTRODUCTION

Recent mobile antennas are being required to be small because the space allocated for antenna in modern mobile devices is becoming smaller. It is difficult to design an antenna with a wide impedance bandwidth and high radiation efficiency using small internal antennas [1], [2]. It was observed in [3], [4] that a wide impedance bandwidth can be achieved by enhancing the coupling between an antenna and the ground plane, even when the antenna is a non-radiating coupling element. Recently, a novel design was proposed [5], [6] in which elements such as an antenna or coupler are not employed, but rather a capacitor is inserted into a small non-ground area of a mobile device. In this work, performance of ground radiation antenna was compared to PIFA, demonstrating that ground radiation antenna can have a better performance than PIFA that has an additional antenna element. PIFA is frequently used as a small and multi-band antenna [7] and the comparison presented here was not conducted in the previous work [5]. In addition, it is shown that the proposed concept can be used in the case of a small ground (50 x 20 mm^2), intended for USB dongle and headset applications. Here, simulation data were obtained in HFSS and experimental data were obtained using a network analyzer and a three-dimensional anechoic chamber.

II. ANTENNA DESIGN AND ANALYSIS

As shown in Figure 1. (a), the size of the ground plane is 50 x 20 mm^2 and printed on a 1mm thick FR-4 substrate (ε_r=4.4 δ=0.02). In the proposed antenna, the capacitance controls the resonance frequency [5], [6]. The PIFA uses a 20.5mm copper line for radiator and the proposed antenna fully utilizes the ground plane for radiation with the use of two chip capacitors.

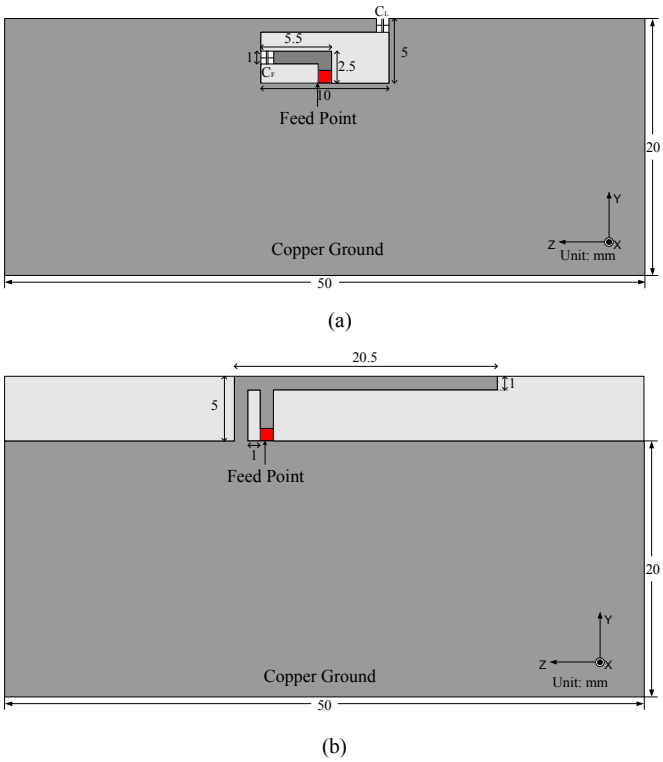

Figure 1. Geometries of (a) ground antenna (b) PIFA.

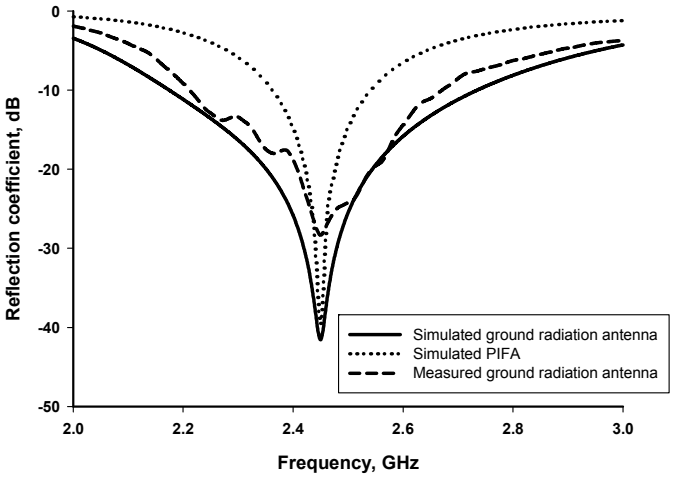

Figure 2. Simulated and measured return loss.

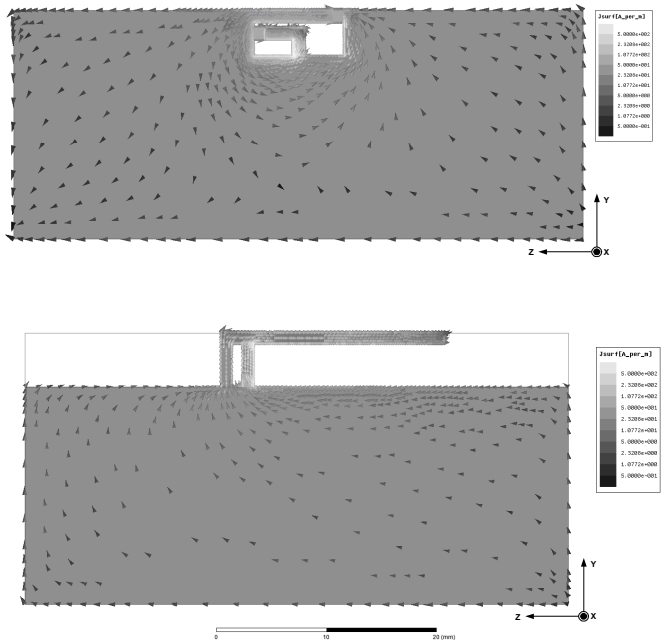

Figure 3. Computed normalized surface current density of (a) ground radiation antenna (b) PIFA at 2.45GHz.

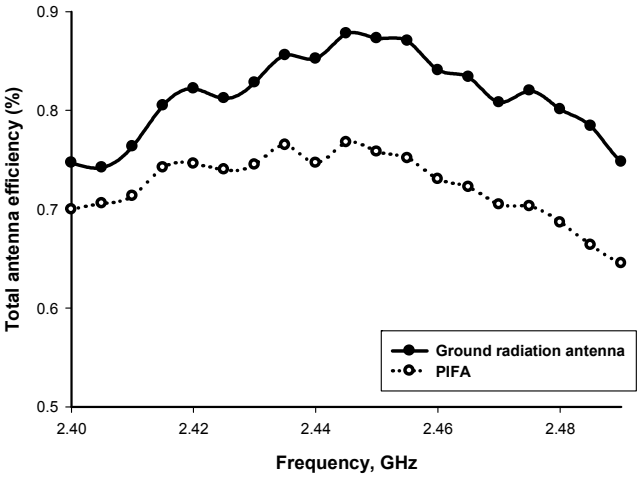

Figure 4. Total antenna efficiency of the Ground radiation antenna and PIFA.

Capacitor C_L is located at the end of the radiator line controlling the resonance frequency and C_F is located in the feed structure controlling the input impedance. The simulated and measured return loss characteristics are shown in Figure 2. The proposed antenna and conventional PIFA are simulated at resonance frequency of 2.45GHz. The surface current density of both antennas at resonance frequency is shown in Figure 3. Loop-type current is formed around the antenna and dipole-type current induced by the loop-type ground can be seen.
Compared to the reference antenna, the ground has a wider current distribution on the ground. Which indicates that the ground antenna can provide a higher ground radiation resistance.

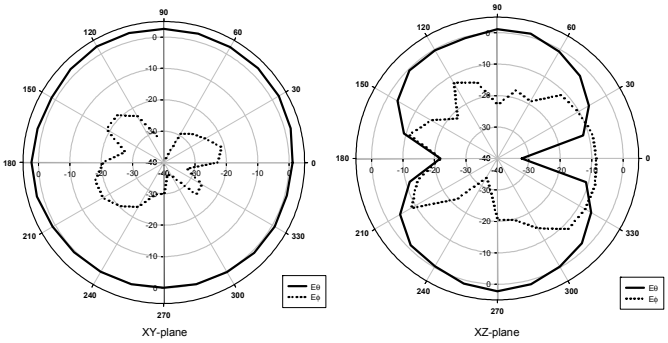

Figure 5. Measured radiation patterns produced by ground radiation antenna at 2.45GHz.

III. EXPERIMENTAL RESULT AND DISCUSSION

Simulation and measured return loss as shown in Figure 2. The ground radiation antennas impedance bandwidth with VSWR= 2 are 310MHz and PIFA is 170MHz operating at 2.4GHz. Ground antenna has wide impedance bandwidth, wider bandwidth than PIFA. Radiation efficiency as shown in Figure 4. The ground radiation antenna has good radiation efficiency than PIFA. The average efficiency of ground radiation antenna is 81.12% and PIFA is 71.87%. As shown in Figure 4. The total antenna efficiency of the ground antenna is higher than that of the reference antenna. These results indicate that the ground radiation antenna provides better radiation than PIFA. Figure 5. shows the measured radiation patterns of the ground radiation antenna. The measured radiation patterns are in very good agreement with the simulated radiation patterns.

IV. CONCLUSION

Simulated and measured return loss is shown in Figure 2. The ground radiation antenna and PIFA has impedance bandwidth under VSWR=2:1 of 560MHz and 170MHz. respectively at operating frequency of 2.4GHz. Ground radiator antenna has a wider impedance bandwidth than PIFA. Radiation efficiency is shown in Figure 4. Ground radiation Antenna has better radiation efficiency than PIFA. The average radiation efficiency of ground radiation antenna is 81.12% and PIFA is 71.87%. By using this method, the size of the antenna has become smaller than conventional PIFA.

ACKNOWLEDGMENT

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